WATER QUALITY FROM ALLUVIAL WELLS AND SPRINGS IN THE UINTA BASIN, EASTERN UTAH

by JANAE WALLACE
UTAH GEOLOGICAL SURVEY, SALT LAKE CITY, UTAH

ABSTRACT

The Uinta Basin in eastern Utah generally lacks sufficient water-quality data from alluvial wells and springs to characterize the area's shallow groundwater. As part of a two-year project studying water-related issues affecting potential shale/tight-sand gas development in the Uinta Basin, this component of the project will establish baseline water quality and examine the vulnerability of the area's shallow alluvial wells and springs.

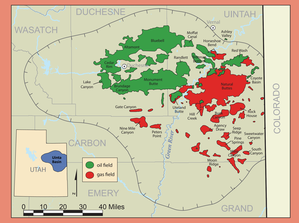
During summer of 2013, I collected 22 water samples from shallow water wells and springs in the Uinta Basin, and had the samples analyzed for a suite of water-quality constituents including total dissolved solids (TDS), nitrate, dissolved metals, total petroleum hydrocarbons (TPH), and some volatile organic compounds (VOCs). Data from all sites show TDS concentrations range from 214 to 5532 mg/L. Specific conductance values for all samples range from 373 to 8370 µmhos; the highest value is from a spring likely emanating from fractures within the Green River Formation at the White River, and the lowest value was from a shallow well in the northern part of the basin near the Uinta Mountains (recharge area). Some sites have VOCs with concentrations above detection levels including benzene, vinyl chloride, bromomethane, chlorobenzene, chloromethane, and toluene. All samples were also analyzed for oxygen and deuterium isotopes.

Ultimately, the main project will investigate the integrated management of water production and disposal for shale/tight-sand gas in the Uinta Basin; this component will develop an alluvial aquifer vulnerability model to show potential contamination from fluids associated with shale/tight sand gas development. Potential water-quality degradation may result from an expected increase in mining activity if sound water-management procedures are not implemented. This regional water study will provide GIS-based information to help local planners and potential developers to preserve the quality of shallow groundwater and springs by establishing best-management practices through careful land-use planning.

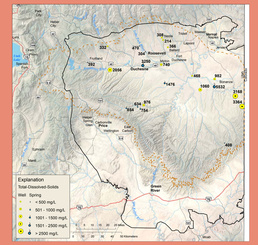
STATEMENT OF THE PROBLEM

This study is a small component of a broader project that addresses the production and disposal of water from shale/tight-sand gas reservoirs. This study addresses water quality in the Uinta Basin, specifically in shallow alluvial aquifers and springs. The bigger issue of the project is how to deal with produced water since it is the largest-volume waste stream associated with unconventional gas plays. Water production and disposal associated with unconventional methods has 1) recently become a topic of much public debate; 2) affects the economics of gas resource development; and 3) has potential to impact land use, and thereby vulnerable aquifers of the Uinta Basin.

The Uinta Basin produced water project is part of a collaborative effort to promote maximized produced-water reuse which will minimize use of freshwater in unconventional gas development and production. This component seeks to increase protection of critical Uinta Basin alluvial aquifers and springs. Please go to: **http://geology.utah.gov/emp/UBproduced_water/index.htm** to see project updates.



Location of the Uinta Basin project area in Utah showing the distribution of oil and gas fields of the Uinta Basin, eastern Utah (modified from Chidsey, 2012).



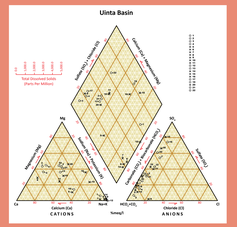
Total-dissolved-solids concentrations for 22 wells and springs sampled during summer 2013 in the Uinta Basin.

Spring (Site ID 12) issuing from the base of the Green River Formation and entering the White River; black color is from gilsonite "detritus" carried by the White River and deposited in overbank pool and not the color of the water; the water is clear. Water also seeps from bedrock above the spring; pink color is unknown, and may be bacteria or manganese.

Sampling springs in the Uinta Basin. Site ID 3 spring is located near Upalco in the northernmost part of the basin, south of the Uinta Mountains recharge area.

Sampling springs in the Uinta Basin. Site ID 1 spring in the north central part of the Uinta Basin.

View of Willow Creek drainage taken from Seep Ridge (view to the northwest) in the central part of the Uinta Basin.



Piper diagram of general solute chemistry for 21 sites sampled during spring and summer 2013 in the Uinta Basin. X's correspond to alluvial well samples, circles correspond to spring samples.

CHEMICAL ANALYSIS FOR 22 SITES

Field parameters: pH, field temperature, specific conductance

General Chemistry

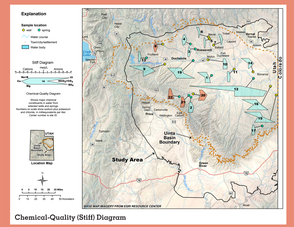
Total Dissolved Solids (TDS) (including calcium, sodium, potassium, magnesium, chloride, bicarbonate, carbonate, and sulfate), total suspended solids (TSS), carbon dioxide, hydroxide, alkalinity, turbidity (NTU), L-specific conductance

Dissolved Metals

arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver, zinc

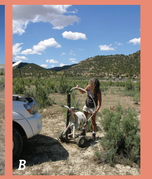
Volatile Organic Compounds and Total Petroleum Hydrocarbons

VOCs (BTEX MTBE) (benzene, bromoethane, bromodichloromethane, bromoform, chloromethane, chloroform, chlorodibromomethane, vinyl chloride, total xylene, toluene)



Chemical-Quality (Stiff) Diagram

Locations of water sampling sites in the Uinta Basin. The sites are identified by their location number. Stiff diagrams illustrate solute chemistry. All data are from 2013. Blue polygons indicate the site was sampled for and had detectable VOCs; orange indicates no VOCs were detected (sites 8, 20, 21, and 22). Diagrams having similar shapes and sizes reflect similar chemistry types; the variability of diagrams reflects different and mixed aquifer sources.



Sampling shallow alluvial wells (< 30-feet deep) that were drilled by the U.S. Geological Survey during the 1970s to understand water quality pre-oil-shale development. Well ID 14 (A) is near the Mountain Fuel Bridge and Well ID 15 (B) is located near Dragon station and Evacuation Creek.

PR Spring Site ID 17

South Camp

PR Spring Site ID 17. Groundwater discharge permits have been approved near the PR Spring area for a tar sand project because the spring itself is a public-supply source, monitoring water quality would be beneficial. Monitoring would also be beneficial at a nearby (less than 1 mile to the east) 50-feet-deep scout camp well since VOCs were detected there in a previous study. Monitoring is not meant to regulate current or future land-use development, but to track the quality of water as a cautionary measure; early detection of pollutants could help avoid costly cleanup.

RESULTS

- TDS – ranges from 214- 5532 mg/L; variable water quality; aquifers and springs are not interconnected
- Nitrate–no sites exceeded 10 mg/L; most <0.1 mg/L
- No dissolved metals exceeded water-quality standards: some metals (e.g., Ba, Cr, and Z) associated with fracking fluids from previous investigations had detectable concentrations:
  - 7 sites for barium
  - 7 sites for chromium
  - 14 sites for zinc
  - 20 sites had above DL for Cu
- Overall low TDS with 77% of sites <2000 mg/L, especially from springs near the recharge area in the Uinta Mountains
- 18 of 22 sites had detectable VOCs, some had 2 or more

SUMMARY

This study was conducted to establish water quality for lands in the Uinta Basin where production and disposal of water from shale/tight-sand gas reservoirs may occur in the future. During the summer of 2013, I collected 22 water samples from shallow alluvial water wells and surface-water (springs) sites in the Uinta Basin. A suite of water-quality constituents were analyzed including total dissolved solids, nitrate, dissolved metals, total petroleum hydrocarbons, and volatile organic compounds. Total-dissolved-solids concentrations for all samples ranged from 214 to 5532 mg/L and nitrate concentrations ranged from <0.1 to 5.32 mg/L for all sites. Dissolved solids were highest from a spring issuing near the White River and lowest from a well near the recharge area of the Uinta Mountains in the north. Overall, samples have variable water quality throughout the study area with water likely from multiple aquifers that are not connected. Most sites (20 of 22) have nitrate concentrations below 1 mg/L. Ultimately, this project seeks to increase protection of critical Uinta Basin alluvial aquifers and springs.

All of the sites sampled vary in terms of their water resource value. Some are perennial springs, some are domestic water supply, some supply water for wildlife, and a few are monitor wells drilled by the USGS during the 1970s. Most of the water, in terms of being potable, could be used as a source for drinking if treated properly, with all but 2 samples having TDS concentrations below 3000 mg/L, the upper limit set by the Utah Water Quality Board as "Drinking Water Quality." Future sampling for heavy metals is recommended to determine if a marked increase occurs, especially in barium, chromium, uranium, and zinc. These metals have been reported in other studies related to fracking. This would be particularly important if large quantities of produced water are disposed – there is concern heavy metals could potentially leach to groundwater. Concentrations measured during this study range from non-detect to a high of 1730 µg/L for barium, 11.5 µg/L for chromium, and 473 µg/L for zinc (all below the MCL). This water study provides vital information to help local planners and potential developers preserve the quality of groundwater and springs by establishing best-management practices through careful land-use planning.

ACKNOWLEDGMENTS

Funded by Small Producer Program of the Research Partnership to Secure Energy for America (RPSEA) and the Utah Geological Survey